What is claimed is:

1. A method of operating a fuel cell, said fuel cell comprising a cathode, an anode, and an electrolyte, said method comprising supplying a fuel stream comprising dimethyl ether to said anode wherein dimethyl ether is directly oxidized at said anode.

2. The method of claim 1 wherein the operating temperature of said fuel cell is less than about 200°C.

3. The method of claim 2 wherein said fuel cell is a solid polymer fuel cell and said electrolyte comprises a proton exchange membrane.

4. The method of claim 3 wherein said fuel stream is a liquid.

5. The method of claim 4 wherein said liquid fuel stream additionally comprises water.

6. The method of claim 5 wherein said liquid fuel stream comprises greater than about 1.5 moles of dimethyl ether per liter of water.

7. The method of claim 5 wherein said liquid fuel stream comprises an additional fuel.

8. The method of claim 7 wherein said additional fuel is methanol.

9. The method of claim 8 wherein said liquid fuel stream comprises greater than about 0.1 mole of dimethyl ether per liter of water.

10. The method of claim 1 wherein said fuel stream is supplied to said anode at a pressure greater than about 4 bar absolute.

11. The method of claim 1 wherein said anode comprises a platinum ruthenium alloy catalyst.

12. The method of claim 1 wherein the oxidant stream supplied to said cathode at a pressure less than about 3 bar absolute.

13. The method of claim 1 wherein the stoichiometry of the oxidant stream supplied to said cathode is less than about 1.6.

14. The method of claim 1 wherein the fuel cell is operated at a current density of less than about 300 mA/cm^2.

15. The method of claim 1 comprising recirculating unreacted dimethyl ether from the anode exhaust of said fuel cell into said fuel stream.

16. The method of claim 1 comprising recirculating unreacted dimethyl ether from the cathode exhaust of said fuel cell into said fuel stream.

17. The method of claim 15 wherein the recirculating comprises separating unreacted dimethyl ether from the anode exhaust by pressure swing absorption, water absorption, or membrane separation.

18. The method of claim 16 wherein the recirculating comprises separating unreacted dimethyl ether from the cathode exhaust by pressure swing absorption, water absorption, or membrane separation.

19. The method of claim 1 comprising introducing dimethyl ether into said cathode before shut down whereby freezing of the cathode during shutdown is prevented.

20. The method of claim 1 comprising varying the composition of said fuel stream supplied to said anode during the operating of said fuel cell.

21. The method of claim 20 wherein the composition varies in accordance with a fuel cell operating parameter.

22. A fuel cell system comprising a fuel cell, said fuel cell comprising a cathode, an anode, and an electrolyte, wherein said anode is fluidly connected to directly oxidize dimethyl ether in a fuel stream supply comprising dimethyl ether.

23. The fuel cell system of claim 22 wherein said fuel cell is a solid polymer fuel cell and said electrolyte comprises a proton exchange membrane.

24. The fuel cell system of claim 23 wherein said fuel stream is a liquid stream and said fuel cell is a liquid feed solid polymer fuel cell.

25. The fuel cell system of claim 24 wherein said fuel stream comprises water.

26. The fuel cell system of claim 25 wherein said fuel stream comprises an additional fuel.

27. The fuel cell system of claim 26 wherein said additional fuel is methanol.

28. The fuel cell system of claim 25 wherein said system comprises:
a mixing apparatus for providing said fuel stream for said fuel cell, said anode fluidly connected to a mixing apparatus outlet; and
supplies of dimethyl ether and water fluidly connected to mixing apparatus inlets.

29. The fuel cell system of claim 27 wherein said system comprises:

a mixing apparatus for providing said fuel stream for said fuel cell, said anode fluidly connected to a mixing apparatus outlet; and

supplies of dimethyl ether, water, and methanol fluidly connected to mixing apparatus inlets.

30. The fuel cell system of claim 28 wherein said system comprises a recirculation loop fluidly connecting an electrode exhaust of said fuel cell to a mixing apparatus inlet.

31. The fuel cell system of claim 30 wherein said recirculation loop comprises a heat exchanger.

32. The fuel cell system of claim 30 wherein said recirculation loop comprises a pressure swing absorption, water absorption, or membrane separation apparatus.

33. The fuel cell system of claim 30 wherein said recirculation loop fluidly connects the cathode exhaust of said fuel cell to a mixing apparatus inlet.

34. The fuel cell system of claim 30 wherein said recirculation loop fluidly connects the anode exhaust of said fuel cell to a mixing apparatus inlet.